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Validation of a Pressed Pentolite Donor for the Large Scale Gap Test (LGST) at DSTO

Craig Wall and Mark Franson

Weapons Systems Division
Defence Science and Technology Organisation

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ABSTRACT

The requirement of validating a new donor for the LSGT used at DSTO has arisen due to changes in ingredient availability for local donor manufacture, and also the availability to import commercial donors from overseas. A donor (manufacture by Accurate Energetic Systems) has been selected for evaluation for use in the LSGT at DSTO by performance and LSGT characterisation. The donor specifications are identical to the donors used in the NOL LSGT and a calibration for the LSGT at DSTO has also been reviewed. The changes recommended in this report have been adopted by DSTO and the test will now be referred to as the DSTO LSGT (previously, the MRL LSGT).

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Telephone: (08) 7389 5555
Fax: (08) 7389 6567

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Executive Summary

The MRL Large Scale Gap Test (LSGT) was commissioned at Materials Research Laboratory (MRL, now the Defence Science and Technology Organisation (DSTO)) in 1993 for the purpose of measuring shock sensitivity of explosive formulations and is still the most common Gap test used by DSTO today. The shock sensitivity of an explosive provides insight into its suitability for military use and involves establishing the amount of pressure required which will permit detonation of the test charge in 50% of fired shots (critical gap).

The requirement of validating a new donor for the Australian LSGT arose due to changes in ingredient availability for local donor manufacture and also the availability to import commercial donors from overseas. A donor (manufactured by Accurate Energetic Systems, AES) was selected for evaluation for use in the LSGT by performance and LSGT characterisation. The donor specifications matched that as used by Naval Surface Warfare Center (NSWC), and thus calibration of the LSGT at DSTO was also reviewed.

The performance evaluation demonstrated that the AES donor provided a consistent velocity of detonation and detonation pressure, which is critical for LSGT. The LSGT trials also produced acceptable results with the new donor. The calibration review determined the Australian LSGT can now become a calibrated system using the AES donor based upon calibration data produced by NSWC for a donor of matching specifications. The previous donors manufactured by DSTO while dimensionally the same as AES, could only be produced with a different (but consistent) density due to the nature of melt cast manufacture. Therefore until now the MRL LSGT had only been capable of producing approximated critical gap pressure results. In light of these changes it was decided an appropriate opportunity to update the name of the test from the MRL LSGT to the DSTO LSGT.

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Glossary

ADF	Australian Defence Force
AES	Accurate Energetic Systems
Al	Aluminium
AP	Ammonium Perchlorate
ARX	Australian Research Explosive
DSTO	Defence Science and Technology Organisation
GPa	Gigapascal
HEFC	High Explosive Firing Complex
ICI	Imperial Chemical Industries
IM	Insensitive Munitions
LSGT	Large Scale Gap Test
MRL	Materials Research Laboratory
NEQ	Net Explosive Quantity
NOL	Naval Ordnance Laboratories
NSWC	Naval Surface Warfare Center
PBX	Polymer Bonded Explosive
$\mathbf{P_{CJ}}$	Chapman-Jouguet (detonation) pressure
P	Relative detonation pressure
Pentolite	PETN/TNT, 50/50
PETN	Pentaerythritol tetranitrate
PMMA	Polymethyl methacrylate
RDX	Cyclotrimethylenetrinitramine
RS-RDX	Reduced Sensitivity RDX
RT 60/40	RDX/ TNT/Wax, 60/40/1
SD	Standard Deviation
SES	Scientific Engineering Services
TNT	2,4,6-trinitrotoluene
VoD	Velocity of detonation

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1. Introduction

The Large Scale Gap Test (LSGT) was commissioned at Materials Research Laboratory (MRL) in 1993 for the purpose of measuring shock sensitivity of explosive formulations and is still the most common Gap test used by the Defence Science and Technology Organisation (DSTO) today. The shock sensitivity of an explosive provides insight into the suitability of explosives for military use in conjunction with the Australian Insensitive Munitions (IM) Policy [DEFLOGMAN, Part 2, Volume 9, Chapter 4] [1].

Gap testing involves establishing the shock input required which will permit detonation of the test charge in 50% of fired shots, this is achieved by placing a gap between the donor and acceptor and its thickness varied according to a developed procedure [6, 7] until detonation results in 50% of the firings.

The MRL LSGT is based on the LSGT developed by Naval Ordnance Laboratory (NOL) [6], now Naval Surface Warfare Center (NSWC), USA. The main difference between the two versions is the MRL LSGT had always used a cast Pentolite (50% PETN / 50% TNT) donor charge instead of a pressed Pentolite donor charge, as used by NSWC. This was due to restrictions which prevented MRL importing the same pressed Pentolite donor as used by NSWC. As a consequence, a cast Pentolite donor (1.65 $g.cm^{-3}$) for the MRL LSGT was used which had a different density with respect to the NSWC pressed Pentolite donors (1.56 $g.cm^{-3}$). As reported by Wolfson [4], this difference in density was expected to produce a slightly higher pressure than the NSWC donor and therefore a slightly higher critical gap when using the DSTO donor. At the time of commissioning the MRL LSGT, it was intended that until the test could be calibrated, the NSWC calibration data [6, 3] would be used to provide an approximation of the pressure at the critical gap. The calibration of the MRL LSGT never eventuated, and as a result had been supplying an approximation for the pressure at the critical gap (see Appendix A, A.2.).

Due to changes in circumstances, a new donor was required to replace the cast Pentolite donors produced by DSTO. The major influencing change was the cessation of PETN manufacture in Australia (by Imperial Chemical Industries (ICI, now Orica)) located at Deer Park, Melbourne). This was of direct consequence to the manufacturing process carried out by DSTO to produce cast LSGT Pentolite donors of a consistent density as described by Wolfson [4] and could not be substituted with a different grade of PETN. The candidate donors selected for an evaluation were manufactured by Accurate Energetic Systems (AES), USA. These donors conformed to the same specification as those used in the NOL LSGT, being pressed Pentolite 1.56 $g.cm^{-3}$.

This report contains a detailed approach to the validation of the AES Pentolite donor in the Australian LSGT system, including performance assessment, LSGT studies on well established formulations and calibration of the donors within the MRL LSGT.

2. Experimental

2.1 Donor Specifications

2.1.1 DSTO manufactured

Donors were manufactured at the Melt Cast Facility located at DSTO Edinburgh according to the procedure established in [4], cast Pentolite, density 1.65 $g.cm^{-3}$, height 50.8 mm x diameter 50.8 mm and NEQ 168 g. To achieve a reproducible density of 1.65 $g.cm^{-3}$, the cast Pentolite charges (240 mm long) were machined in a specific fashion to produce two donors per charge.

2.1.2 Accurate Energetic Systems

Pressed Pentolite to a density of 1.56 $g.cm^{-3}$, height 50.8 mm x diameter 50.8 mm and NEQ 160 g. All donors used in this assessment originated from Lot number 23FE09A1.

2.2 Performance Testing

Performance assessment of both the DSTO and AES donor was carried out at the High Explosives Firing Complex (HEFC) at DSTO, Edinburgh. The assessment comprised of measuring the Velocity of Detonation (VoD) using DSTO designed VoD flexible circuit-board[1] and Relative Detonation pressure (P). Charges were initiated on witness plates measuring 50 mm thick, 250 grade steel with Rockwell hardness B74-76.

2.2.1 Velocity of Detonation

Charges were prepared in a triplicate set from both types of donor. Charges were made 254 mm long by securing five donors from the same origin in a vertical configuration. All charges were fitted with a VoD flexible circuit board (Fig. 1a) and initiated using an EBW detonator secured to an AES booster.

[1] DSTO's VoD circuit-board provides a ten point (10 points each at 20 mm spacing) mechanism to determine the rate of passage of the detonation front. The system is attached parallel to the charge on the outer surface of the charge. Simple calculation of the VoD over each of the nine intervals via CRO provides evidence of accelerating, decelerating or steady-state detonation of the charge [13].

Figure 1: (a) VoD charge configuration (b) Single donor dent test setup in the DSTO HEFC

2.2.2 Detonation Pressure

The firing program consisted of two charge configurations (both fired in triplicate) made up exclusively of DSTO or AES donors. The first configuration consisting of a stack of 5 donors giving a charge length of 254 mm plus a 50.8 mm booster. The second configuration consisted of a single donor (Fig 1b). The Relative Pressure of each donor type was determined via the dent test technique [2] and referenced to RT 60/40 charges of identical diameter [2, 8]. Dent depths were measured on a Sheffield Endeavor coordinate measuring machine (Model 9.12.7) by Scientific Engineering Services (SES), DSTO.

2.3 Large Scale Gap Testing

The LSGT was used to evaluate both donor types at Pt Wakefield, Joint Proof and Experimental Unit. Three formulations were selected, PBXN-109 (64% Type 2 RDX / 20% Al / 16% Binder), PBXW-115 (Aust) (20% Type 1 RDX / 25% Al / 43% AP / 12% Binder) and RT 60/40 (60% RDX / 40% TNT / 1% Wax) and assessed with both donor types. One series of the Australian variant of PBXN-109 was also assessed, ARX-2014 (64% Type 1 RDX / 20%Al / 16% Binder) using the AES donors and results compared to the existing critical gap data produced from DSTO donors.

It should be noted the acceptor charges for PBXN-109, PBXW-115 (Aust) and RT 60/40 were all cast from a single mix, and each PBX formulation series cast simultaneously, while the Composition B series were cast via the routine melt cast procedure. The RDX used in PBXN-109 (Type 2, BAE) was dried at 60 °C for a maximum of five days before being used.

The complete LSGT setup can be seen in Figure 2 and the method described by Wolfson [4], was followed.

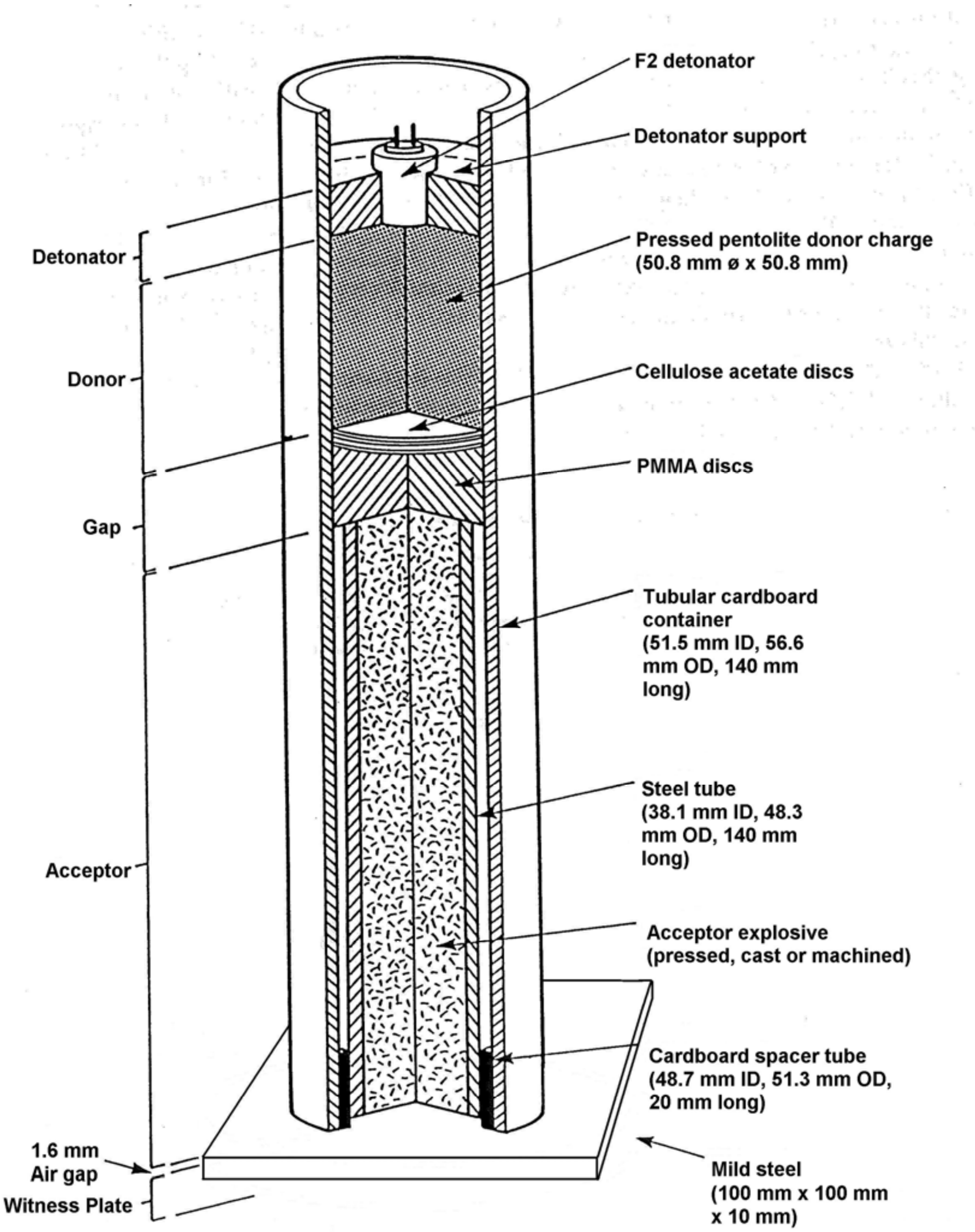

Figure 2: Schematic diagram of the LSGT

3. Results

3.1 Performance Testing

3.1.1 Velocity of Detonation

The velocity of detonation of both donor types are displayed in Table 1, DSTO donors produced an average velocity of 7522 $m.s^{-1}$ and AES donors having a slightly lower average velocity of 7306 $m.s^{-1}$. This result was expected due to the difference in density between the two donor types; the DSTO donor having a higher VoD due to its increased density and thus a faster shockwave was produced.

Table 1: Experimental detonation velocities for DSTO and AES donors

Donor Origin	**Density ($g.cm^{-3}$)**		**VoD ($m.s^{-1}$)**
DSTO	1.65		7520
DSTO	1.65		7538
DSTO	1.65		7508
		Average	***7522***
AES	1.56		7300
AES	1.56		7306
AES	1.56		7312
		Average	***7306***

3.1.2 Relative Detonation Pressure

The dent depth and relative detonation pressure (P) produced from both charge configurations are displayed in Table 2. The difference between the dent depth and detonation pressure for the single and stacked configurations is accounted from the shockwave produced by a single booster which is unable to reach maximum speed over a 50.8 mm length and therefore a smaller dent (lower detonation pressure) is produced. The data shows consistency for both donor types and the results reflect the expected outcome in regards to the difference in density.

Table 2: Dent Depth and Detonation Pressure results for DSTO and AES donors

Donor Origin	Density ($g.cm^{-3}$)	Charge Length (mm)		Dent Depth (mm)	Experimental P[a] (GPa)
DSTO	1.65	254		9.8	25.6
DSTO	1.65	254		10.1	26.4
DSTO	1.65	254		9.6	25.1
			Average	***9.8***	***25.7***
AES	1.56	254		9.3	24.3
AES	1.56	254		9.0	23.6
AES	1.56	254		9.1	23.7
			Average	***9.1***	***23.9***
DSTO	1.65	50.8		8.5	22.2
DSTO	1.65	50.8		8.6	22.5
DSTO	1.65	50.8		8.2	21.5
			Average	***8.4***	***22.1***
AES	1.56	50.8		7.8	20.3
AES	1.56	50.8		7.8	20.5
AES	1.56	50.8		7.9	20.7
			Average	***7.8***	***20.5***

[a] based on dent depth measurement and referenced to RT 60/40

3.1.3 Modelling Data

The VoD and P_{CJ} were calculated using CHEETAH 4.0 (Table 3), which utilises traditional Chapman Jouget thermodynamic detonation theory to accurately model and predict performance of new explosive compositions as well as ideal explosives. It should be noted that CHEETAH assumes the charge is of infinite length as it can not model size effects. It can be seen good agreement exists between the 254 mm experimental charges and the modelled VoD and pressure values.

Table 3: Performance data calculated from CHEETAH 4.0 and Experimental data

Donor Origin	Density ($g.cm^{-3}$)	Calculated P_{CJ} (GPa)	Experimental P (GPa)	Calculated VoD ($m.s^{-1}$)	Experimental VoD ($m.s^{-1}$)
DSTO	1.65	25.0	25.7	7281	7522
AES	1.56	23.3	23.9	7019	7306

3.2 Large Scale Gap Testing

The LSGT was carried out on formulations RT 60/40, PBXN-109 and PBXW-115 (Aust) using both AES and DSTO donors (Table 4). The Australian version of PBXN-109, ARX-2014 which uses Type 1 RDX was also tested with AES donors, and compared to existing data generated previously with the DSTO donor as a limited supply of DSTO donors was available. The Critical Gap pressure for both donor types was calculated using the calibration data [6] as found in Appendix A, and as a consequence the DSTO donor values are approximate, due to the density of 1.65 g.cm^{-3}.

It should be noted several other series of PBXN-109 (using BAE RDX) were tested with AES donors (results not included in this report), which displayed an increase in shock sensitivity using both donor types. The results of these series were not consistent with each other and the expected critical gap value. It was observed the RDX used in these series had a light brown colour after being stored in a 60 °C oven for an unmonitored period of time (months), it is possible findings as reported in [12] contributed to this inconsistency. Casting was not done simultaneously which could have also been a contributing factor.

The reported values for PBXN-109 (Table 4) contained Class 1, Type 2 BAE RDX (lot: BAE04M017-039) which was dried at 60 °C for no more than five days. All acceptor charges were cast from the same mix and all PBX series were cast simultaneously for extra consistency, with the exception of ARX-2014 in which only one series was tested with AES donors due to DSTO donor shortage.

Table 4: LSGT results on formulations tested with both DSTO and AES donors

Formulation	Donor Origin	Density (g.cm^{-3})	50% Critical Gap Number of cards	50% Critical Gap Pressure (GPa)
RT 60/40	DSTO	1.65	200	2.1
RT 60/40	AES	1.56	187	2.4
PBXN-109	DSTO	1.65	141	4.4
PBXN-109	AES	1.56	131	4.7
ARX-2014 [11]	DSTO	1.65	117	5.1
ARX-2014	AES	1.56	115	5.2
PBXW-115 (Aust)	DSTO	1.65	91	6.1
PBXW-115 (Aust)	AES	1.56	91	6.1

The LSGT results display the expected trend of a lower number of cards required at the 50% critical gap for the AES donors, with the exception of PBXW-115 (Aust) having an identical critical gap with both donor types.

4. Calibration

All previous 50% critical gap pressures produced by MRL LSGT using the DSTO donor have been approximated using a single curve fit (Appendix A) to the pressure versus distance relationship for a 50.8 mm Pentolite donor (1.56 $g.cm^{-3}$) as outlined in [6].

The LSGT in use at DSTO is now able to produce a precise value in regards to the Critical Gap Pressure due to the AES pentolite donor conforming to the exact same specifications of the donor used in the LSGT calibration as performed by NSWC [6]. The PMMA gap in the LSGT is used to control the amount of shock being delivered to the acceptor charge. The thickness and shock strength are not simply related, so it is necessary to carry out a calibration to determine the pressure as a function of the gap thickness [6].

The calibration data was obtained by NSWC by establishing several key relationships. The first was establishing a consistent PMMA Hugoniot, represented by equations (1) and (2). These equations were derived from plotting the experimental data, Shock Velocity (U) as a function of Particle Velocity (u) for PMMA, with a cubic constrained to become tangent to the straight line of equation (2).

$$U = 2.7228 + 4.0667\,u - 10.9051\,u^2 + 10.6912\,u^{-3},\ 0.03 \le u \le 0.5363 \quad (1)$$

$$U = 2.561 + 1.595\,u,\ u > 0.5363 \quad (2)$$

Where,
U is the shock velocity (mm/μs) of PMMA
u is the particle velocity (mm/μs) of PMMA

The second relationship that was established was Particle Velocity (u) of the PMMA attenuator versus Gap Distance. Particle Velocities in varying lengths of PMMA attenuator were measured using the Electromagnetic Velocity Method (EMV) and 50.8 mm x 50.8 mm pentolite donors, pressed to 1.56 $g.cm^{-3}$. The Peak Particle Velocities (mm/μs) were plotted against Gap Distance (mm) and equation (3) was deemed to be an appropriate function [6]. This produced equation (4) which allows the particle velocity to be calculated for a particular gap distance (x). Due to a distinct change in the slope of the Particle Velocity versus Gap Distance relationship at about 35 mm, it was decided data beyond 35 mm must be fitted with another function (equation 5) [6].

$$u = A\exp(-Bx) + C\exp(-Dx) \quad (3)$$

$$u = 1.7735\exp(-0.01841\,x) + 0.8765\exp(-0.3495) \text{ for } x \le 36.00 \text{ mm} \quad (4)$$

$$u = 0.0905 + 4.0877\exp(-0.04451\,x) \text{ for } x > 36.00 \text{ mm} \quad (5)$$

Where,
x is gap distance (mm)
u is the particle velocity (mm/μs)

As the two relationships have been defined (eqns 1, 2 and 4, 5), the pressure (P) at the 50% critical gap can be calculated for the AES pentolite donor charge using equation (6). The pressure values at the 50% critical gap are outlined in Table 5.

$$P = P_0 \, u \, U \qquad (6)$$

Where,
P_0 is the density of PMMA, 1.185 g.cm^{-3}
U is the shock velocity (mm/µs) of PMMA
u is the particle velocity (mm/µs) of PMMA

5. Discussion

The characterisation data of the pressed Pentolite donors manufactured by AES has shown consistency over all the tests performed. They have exhibited a reduced pressure output and VoD than the melt cast donors due to a lower density. The experimental performance findings have been further validated by the acceptable alignment with CHEETAH 4.0 modelling. The LSGT results follow the trend of a less powerful AES donor, and show slightly lower gaps are required than the DSTO donor. If the DSTO donor had a calibrated system, it would be expected the pressure results would be the same as the AES donors. It needs to be remembered in the case of PBXW-115 even though the same 50% gap was achieved, the pressure results aren't actually the same, the DSTO donor would produce a value higher than 6.1 GPa (if the donor was calibrated).

The LSGT can now become a calibrated system, as the new donor (as manufactured by AES) conform to the same specifications [10] as used by NSWC, and therefore DSTO has incorporated the well established NOL LSGT calibration data into its test.

At the conclusion of this work it was decided an appropriate point in time to rename the MRL LSGT to the DSTO LSGT which marks the changes within the test and to align it with the organisations name. DSTO will benefit in numerous ways changing from the in house produced cast donor to importing the pressed donors as manufactured by AES. The melt cast manufacturing process of these precision donors was labour and time intensive, importing donors will free up manufacturing facilities and staff for other tasks. Another benefit is now the DSTO LSGT replicates the NOL LSGT; only a minor dimensional difference exists with the witness plate [10], therefore making comparisons between the two possible.

6. Conclusion

The DSTO LSGT has been commissioned with the pressed Pentolite donor as manufactured by Accurate Energetic Systems, replacing the MRL LSGT [4]. The DSTO LSGT is now a calibrated system based on the well established data as produced by NSWC.

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Appendix A: Calibration Data

A.1 DSTO LSGT calibration data for AES Pressed Pentolite Donor

Table 5: DSTO LSGT calibration data, derived from [6], Number of cards in gap is the sum of a number in the first row and a number in the first column. One card is 0.01 inch; pressure in GPa.

	0	1	2	3	4	5	6	7	8	9
0	21.30	20.25	19.29	18.42	17.63	16.92	16.27	15.68	15.14	14.65
10	14.20	13.79	13.41	13.06	12.73	12.43	12.16	11.90	11.66	11.44
20	11.23	11.04	10.85	10.68	10.52	10.37	10.22	10.09	9.96	9.83
30	9.72	9.60	9.50	9.39	9.30	9.20	9.11	9.02	8.93	8.85
40	8.77	8.69	8.62	8.54	8.47	8.40	8.33	8.26	8.20	8.13
50	8.07	8.01	7.95	7.89	7.83	7.77	7.71	7.66	7.60	7.55
60	7.49	7.44	7.39	7.33	7.28	7.23	7.18	7.13	7.08	7.03
70	6.98	6.93	6.89	6.84	6.79	6.75	6.70	6.66	6.61	6.57
80	6.52	6.48	6.43	6.39	6.35	6.31	6.26	6.22	6.18	6.14
90	6.10	6.06	6.02	5.98	5.94	5.90	5.86	5.82	5.78	5.74
100	5.71	5.67	5.63	5.59	5.56	5.52	5.49	5.45	5.41	5.38
110	5.34	5.31	5.27	5.24	5.21	5.17	5.14	5.10	5.07	5.04
120	5.01	4.97	4.94	4.91	4.88	4.85	4.82	4.78	4.75	4.72
130	4.69	4.66	4.63	4.60	4.57	4.54	4.52	4.49	4.46	4.43
140	4.40	4.37	4.35	4.28	4.22	4.16	4.10	4.05	3.99	3.94
150	3.89	3.83	3.78	3.73	3.68	3.63	3.58	3.54	3.49	3.44
160	3.40	3.36	3.31	3.27	3.23	3.18	3.14	3.10	3.06	3.02
170	2.99	2.95	2.91	2.87	2.84	2.80	2.77	2.73	2.70	2.67
180	2.63	2.60	2.57	2.54	2.51	2.48	2.45	2.42	2.39	2.36
190	2.33	2.30	2.28	2.25	2.22	2.20	2.17	2.15	2.12	2.10
200	2.07	2.05	2.03	2.01	1.98	1.96	1.94	1.92	1.90	1.88
210	1.86	1.84	1.82	1.81	1.79	1.77	1.75	1.74	1.72	1.70
220	1.69	1.67	1.65	1.64	1.62	1.61	1.59	1.58	1.56	1.55
230	1.53	1.52	1.51	1.49	1.48	1.47	1.45	1.44	1.43	1.41
240	1.40	1.39	1.38	1.37	1.35	1.34	1.33	1.32	1.31	1.30
250	1.29	1.27	1.26	1.25	1.24	1.23	1.22	1.21	1.20	1.19
260	1.18	1.17	1.16	1.15	1.14	1.13	1.13	1.12	1.11	1.10
270	1.09	1.08	1.07	1.06	1.06	1.05	1.04	1.03	1.02	1.02
280	1.01	1.00	0.99	0.98	0.98	0.97	0.96	0.95	0.95	0.94
290	0.93	0.93	0.92	0.91	0.91	0.90	0.89	0.89	0.88	0.87
300	0.87	0.86	0.86	0.85	0.84	0.84	0.83	0.83	0.82	0.81
310	0.81	0.80	0.80	0.79	0.79	0.78	0.78	0.77	0.77	0.76
320	0.76	0.75	0.75	0.74	0.74	0.73	0.73	0.72	0.72	0.71
330	0.71	0.70	0.70	0.70	0.69	0.69	0.68	0.68	0.67	0.67
340	0.67	0.66	0.66	0.66	0.65	0.65	0.64	0.64	0.64	0.63
350	0.63	0.63	0.62	0.62	0.62	0.61	0.61	0.61	0.60	0.60
360	0.60	0.59	0.59	0.59	0.58	0.58	0.58	0.58	0.57	0.57
370	0.57	0.56	0.56	0.56	0.56	0.55	0.55	0.55	0.55	0.54
380	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.52	0.52	0.52
390	0.52	0.51	0.51	0.51	0.51	0.51	0.50	0.50	0.50	0.50
400	0.50									

Note: Results are nominal for 0 to 39 cards [10].

A.2 Previous data used for DSTO LSGT Pressure approximation via curve fit

Table 6: NSWC pressure-distance calibration data [3, 6] for a PMMA attenuator and pressed Pentolite donor (1.56 g.cm^{-3}).

Distance (mm)	Pressure (GPa)
0	21.31
5	11.30
10	8.82
15	7.54
20	6.58
25	5.77
30	5.07
35	4.46
40	3.51
45	2.73
50	2.15
55	1.75
60	1.45
70	1.04
80	0.78
90	0.61
100	0.51

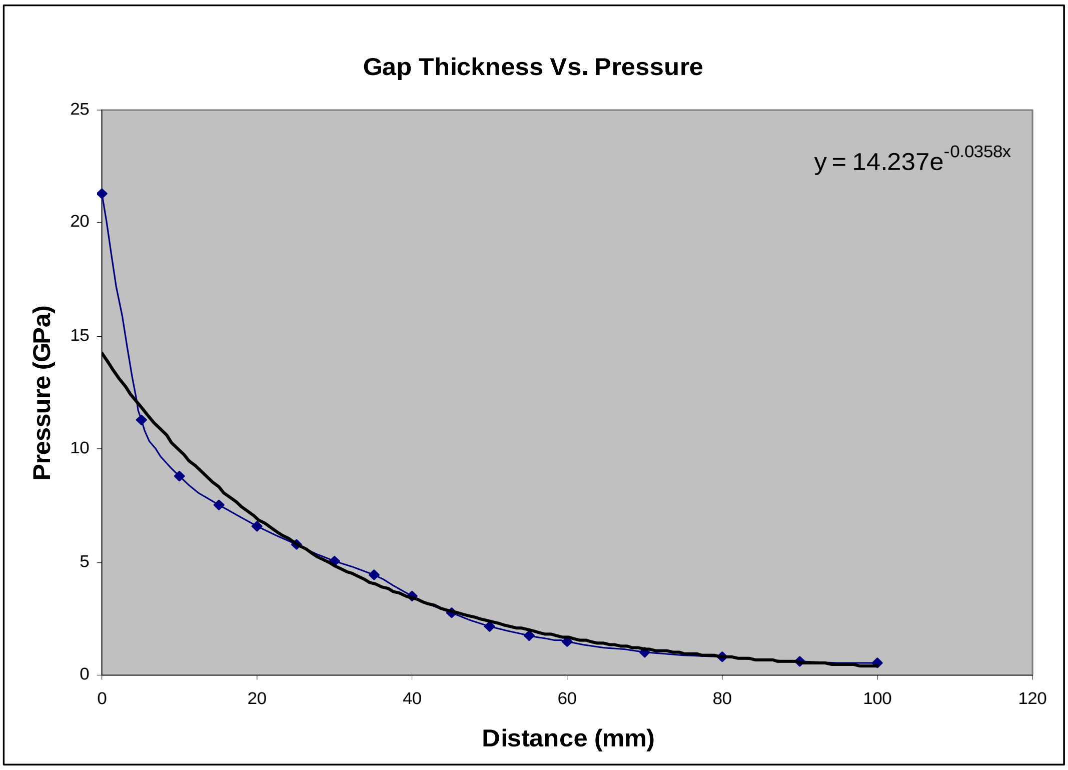
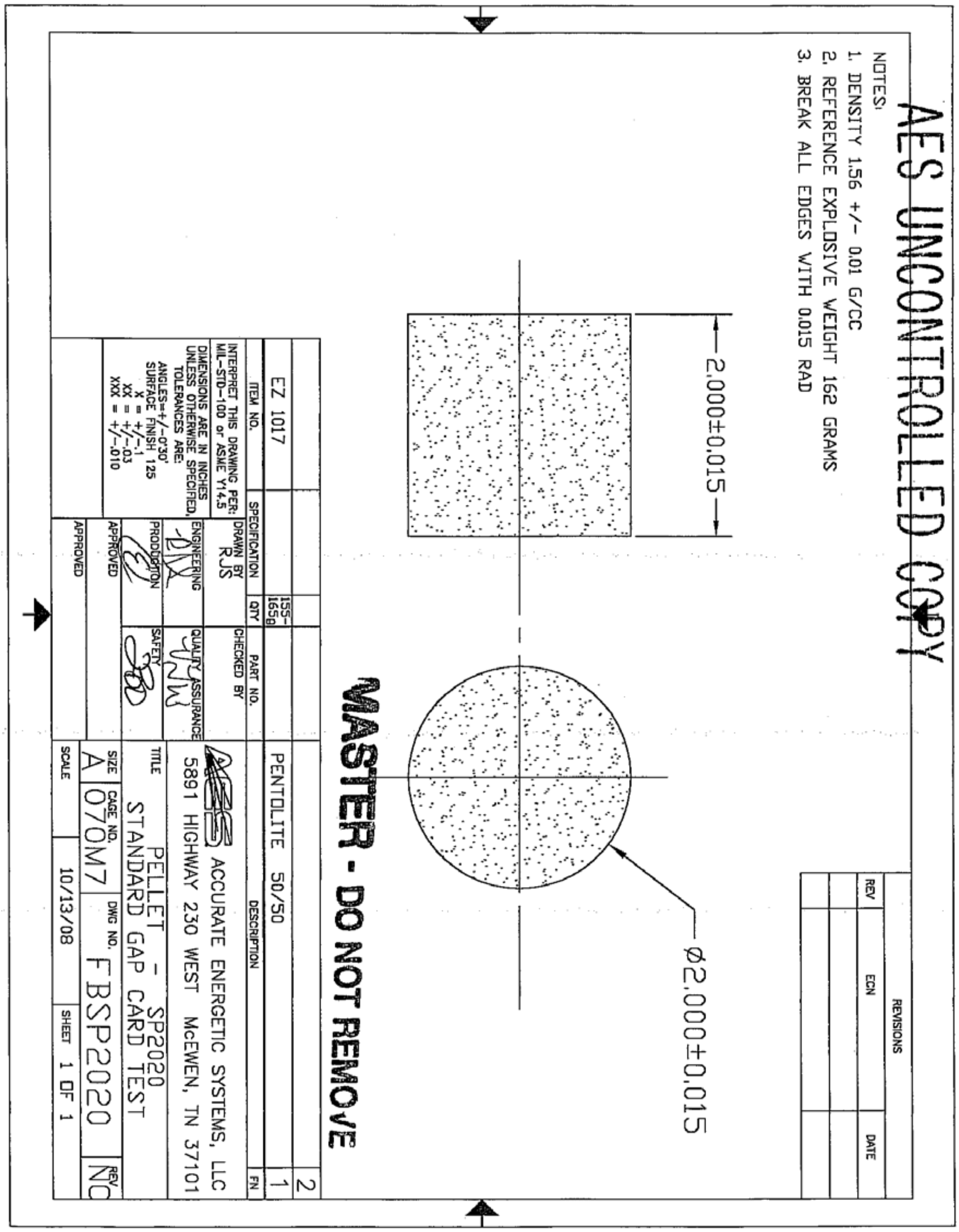


Figure 3: Thickness versus pressure for a PMMA gap and pressed Pentolite donor [3, 6]

A.3 AES Donor Technical Drawing



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Craig Wall and Mark Franson</td><td colspan="3">5. CORPORATE AUTHOR

DSTO Defence Science and Technology Organisation
PO Box 1500
Edinburgh South Australia 5111 Australia</td></tr>
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<tr><td colspan="6">19. ABSTRACT
The requirement of validating a new donor for the LSGT used at DSTO has arisen due to changes in ingredient availability for local donor manufacture, and also the availability to import commercial donors from overseas. A donor (manufacture by Accurate Energetic Systems) has been selected for evaluation for use in the LSGT at DSTO by performance and LSGT characterisation. The donor specifications are identical to the donors used in the NOL LSGT and a calibration for the LSGT at DSTO has also been reviewed. The changes recommended in this report have been adopted by DSTO and the test will now be referred to as the DSTO LSGT (previously, the MRL LSGT).</td></tr>
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